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Status and use of water supply and sewerage systems in the Northern Development Region of the Republic of Moldova

Petru Bacal*, Ana Jeleapov, Daniela Burduja
Institute of Ecology and Geography, Chisinau, 1 Academiei Street, MD-2028, Republic of Moldova;
pbacal16@gmail.com (P.B.); anajeleapov@gmail.com (A.J.); danavirlan3@gmail.com (D.B.)

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Abstract: Water is an important resource for evolution and development of the economy of the North Development Region of the Republic of Moldova. From its availability and facilities to supply depend over 909 thousands inhabitants or 25% of the country population. The most important water resources are surface water that are represented mainly by the Dniester and the Prut rivers situated at the borders of the pilot region as well as groundwater. Internal rivers are characterized by low flow and do not represent significant resources. Surface water resources lead to decrease for the last decades due to different factors including reservoirs impact as well as climate change. Development of water supply and especially water sewerage system is an important factor in order to assure people and industries with water and qualitative life. In this regard, plus to evaluation of water resources dynamics, the aim of the present research is to identify the regional and local assessment of the state and use of public water supply and sanitation systems in the mentioned region for the last decade (2010-2020). Thus, total volume of abstracted water for public water supply systems was, on average, 18,800,000 m^3. For the study period, the total volume of water delivered to the population increased by 1.8 times (4,100,000 m^3), including in rural areas by 4.5 times (by 2,600,000 m^3), and in urban areas, by only 35 % (1,600,000 m^3). As a result of the expansion of the aqueduct network, ≈½ (48%) of the population of region has access to public water supply systems, including 83% in urban areas and only 31% in rural areas. Despite the rapid expansion of public aqueducts, water consumption per capita is low and is only 71 l/day, including 84 l/day in urban areas and only 53 l/day in rural areas. Population access to the public sewerage systems is only 19%, including 55% in the urban areas and only 0.3% – in the rural areas. Slow expansion of the public sewerage systems is caused by higher costs compared to water supply systems, and most local public authorities do not consider them as a priority.

Key words: North Development Region of Moldova, water resources, water use, water supply and sewerage systems, regional and local analysis, climate changes.

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1. INTRODUCTION

At present, given the intensification of climate change and its effects as well as continuing increase of the needs in water resources for population and industries, the supply with qualitative water resources is the key public policy in most countries of the world, especially in those with water scarcity. For this purpose, the permanent evaluation of the available water resources and the particularities of their use represent one of the most requested directions of scientific research, of a great theoretical and applied value. In the Republic of Moldova, the most important water resources are surface water that are represented mainly by the Dniester and the Prut transboundary rivers situated at the borders of the country as well as groundwater, internal rivers representing only local importance. Even if the volumes of main river are considerable, their usage is limited due to different factors, including depletion of water resources, big distance from main rivers, decreasing water quality etc. Water supply and sewerage system

* Corresponding author: pbacal16@gmail.com; Tel.: +373-693-52-816

construction is of a high concern at present in the Republic of Moldova due to low assurance of people and industries with centralized water supply. In urban area, 83% from inhabitants have access to centralized water supply and 55% to centralized sewerage system. In rural area, the access of population to the public aqueducts is 48%, but access to the public sewerage systems is only 0.3%.

In different regions of the country situation with water supply and sewerage system and all its elements and characteristics differ. In this regard, the aim of the present research is to identify the regional and local assessment of the state and use of public water supply and sanitation systems in the North Development Region of the Republic of Moldova. The main objectives of this study are: 1) estimation of surface and groundwater resources; 2) assessment of the current state of the public water supply and sewerage systems and their main components; 3) estimation of the access of the urban and rural population to the public water supply and sewerage supply systems and the level of their use; 4) analysis of the volume of water delivered to population and other categories of beneficiaries of public water supply systems; 5) identification of the evolution trends of the public water supply and sewerage systems and their capacities of utilization; 6) identification of the current achievements and problems of mentioned systems operation and elaboration of recommendations for their development.

2. LITERATURE REVIEW

Worldwide scientific publications devoted to water resources are multiple. A big part of the studies is oriented to description and analysis of hydrological time series of different rivers in many countries, water availability [11,12] other part contains hydrological modelling [13], other part estimates human impact as well as climate change effect on waters [14]. Special effort is made by scientists in order to evaluate quality of water resources and a consequence to identify and apply the most effective methods to combat pollution and degradation of water resources [15].

From those 17 global development goals established by 2030 in the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015 [16] the 6th one is devoted to water "Ensure availability and sustainable management of water and sanitation for all". Thus, water as a main resource to maintain life on our planet is the object of special interest and extensive studies. In this regard, this valuable resource should be managed in a sustainable way in order to assure with water resources in a balanced way ecosystems, people and economic needs.

In the Republic of Moldova, research in the field of water resources was performed by a few scientists. Most famous of them are Lalikin N. [17], Melniciuc O. [18,19]. Lalikin N. dedicated his research to evaluation of water resources and their changes due to human impact, reservoirs characteristics, sediment transport process at national scale. Melniciuc O. expressed his wide experience in the field of hydrology by development of a large number of publications devoted to theory of flow generation, regional synthesis of hydrological characteristics, mathematical modelling, sediment transport evaluation, human impact on rivers, evaluation of floods and low flow etc. The quality of surface and groundwater is reported in the scientific publications coordinated by Sandu M. and Lozan R., also from the Institute of Ecology and Geography [20], as well as in the recent Report on the quality of water in the urban public aqueducts [21].

Through relevant publications in the field of water, important are national reports State of the environment in the Republic of Moldova [22], which present short analysis of water resources as well as tables with water flow dynamics and types of water flow components such as: natural, real, environmental and available at o certain temporal scale. A comprehensive study on the rivers of Moldova is presented in a special edition Water Resources [23], which contains methodological base for evaluation of hydrological characteristics, as well as an extensive analysis of the Republic of Moldova's rivers and their basins, also a special attention was paid to evaluation of hydrological regime and phases of every river subject to monitoring. Actual and impactful documents are management plans of the Danube-Prut and Black Sea River Basin District [24] and Dniester river basin district [3]. These documents are developed and approved in 2017 and 2018 in accordance with water frame Directive 2000/60/EC [25] and contain analysis of the basins and rivers, evaluation of water resources, human impact on water bodies as well as plan of measures in order to improve water status and potential.

Very few researches were developed for evaluation of water resources of the North Development Region of the Republic of Moldova. Only in the last years some articles on general analysis of hydrological characteristics of the main river in the North DR [6, p. 58-63, 8, p. 12-30]. Ensuring the wide access of the population of the Republic of Moldova to public water supply and sanitation systems is reflected in recent analytical studies coordinated by OECD [26-28] and EPIRB (Environmental Protection of International

River Basins) [24], national [29-30] and regional sectorial strategic documents [31], as well as in the scientific researches [32], including of the authors of this study [3-8,33].

3. STUDY AREA

The North Development Region (DR) of the Republic of Moldova includes 11 districts and Balti municipality [1,2]. The total area of RD Nord is 10,000 km^2, which represents 30% of the total area of the country. Actual population is 909,000 inhabitants (25%), including 128,000 inhabitants of Balti municipality [3]. The biggest part of the study region is located within the Răut River basin (the main right tributary of the Dniester River), including districts Donduseni, Soroca, Drochia, Floresti, Sangerei, as well as Balti city [4]. The western part of the region is located in the Prut river basin, including Briceni, Edinet and Glodeni districts and almost all territory of Falesti (80%), Rascani (60%) and Ocnita districts [5].

The Dniester and Prut rivers are the most important water resources, but their exploitation capacities are limited, especially those of the Dniester River. The rivers, especially small and medium-sized, are regulated by reservoirs, the presence of which has both positive effects (flood prevention, irrigation, fish farming, tourism) and negative effects, especially of environmental nature [6, p. 58-63].

Groundwater reserves are sufficient in most districts, except Glodeni, Briceni, Soroca and Ocnita, being influenced by the operation of the Dniester Hydropower Complex (upstream from the village of Naslavcea) on the Dniester river and Costești-Stanca Hydropower Complex – on the Prut River [7, p. 14-15]. The majority of districts and rural settlements are supplied from groundwater sources, but local water resources are insufficient and the water quality is non-conforming with standards. For households mainly used groundwater from the Badenian-Sarmatian aquifer complex with richer reserves [8, p. 18]. Water treatment plants operate on the main aqueducts from the Dniester and Prut rivers, as well as in the cities, which are supplied from groundwater sources. At the same time, in the absolute majority of rural settlements, water treatment is not performed according to the standards in force [9,10].

Water supply volume varies depending on the size of the districts and their urban centers, on the number of households and other categories of water users connected to public aqueducts, available water reserves and on the capacities of abstraction, treatment, transportation and use of water [7, p. 59].

4. METHODS AND DATA

A set of methods was used to assess the characteristics of the North RD water resources, among which the most important are: statistical methods, mathematical modelling, cartographic and analytical methods. Statistical methods are used to assess the temporal dynamics of hydro meteorological features that are subject to multiannual observations. Mathematical modelling is used to assess the quantitative characteristics of water resources of rivers that are not monitored. Analysis of hydrological characteristics was performed based on the national normative document "Determination of hydrological characteristics for the conditions of the Republic of Moldova. Normative in constructions CP D.01.05-2012" [34].

The cartographic methods based on GIS techniques are used for spatial representation of water resources, water supply and sewerage systems at local and regional levels. The analytical method was used for: a) to identify quantitative and qualitative aspects of public water supply and sewerage systems; b) diagnosis of situation of water use and elaboration of recommendations to prevent problematic situations in this field; c) definition of priority directions of activity optimization of water resources management at regional and local levels. SWOT analysis method is applied for identification of problems and opportunities regarding the state of water supply and sewerage systems.

The main informational and statistical support of this study included: 1) Hydrological yearbooks of State Hydro meteorological Service [35]; 2) State Water Cadastre [36]; 3) National Geospatial Data Fund [37]; 4) Reports of National Bureau of Statistics on public water supply and sewerages networks [38] and of population dynamics [39]; 5) Reports of Association „Moldova Apa-Canal"[40]; 6) Annual Reports of State Inspectorate for Environmental Protection [9-10]; National Ecological Fund [41].

5. RESULT AND DISCUTIONS

5.1. Water resources

5.1.1. Surface water resources

Large rivers

Although these are located on the eastern and western borders of the study region, the Dniester and Prut rivers form the most important water resources [8, p.12-17]. The increasing distance from them

reduces the degree of access and leads to use of alternative sources, especially groundwater, which are usually exploited at higher operating costs [7, p. 15].

The Dniester River is the main river of the Republic of Moldova. Within the limits of the North RD, the Dniesterriver flow is monitored at Grushka station, and water level at Naslavcea, Unguri, Soroca, Sanatauca (Table 1). At Grushka station, average water flow is 305 m^3/s, water layer – 198 mm, and average water volume – 9.6 km^3.

Table 1. Hydrological characteristics of rivers within the North Development Region.

River	Hydrologic station	Period, years	Average water flow, m^3/s	Average water flow, $l/s\ km^2$	Water layer, mm	Average water volume, mil. m^3
Large rivers						
Dniester	Grushka	1968-2019	306	6.28	198	9647
Prut	Sirăuţi	1990-2019	72.1	7.82	247	2276
Prut	Costeşti-Stânca	1982-2017	76.0	6.44	203	2396
River from the Dniester River Basin						
Răuţ	Bălţi	1972-2017	1.46	1.36	42.75	46.17
Cubolta	Cubolta	1966-2017	1.65	1.90	60.0	52.14
Cainari	Sevirova	1954-2017	1.29	1.59	50.05	40.76
River from the Prut River Basin						
Vilia	Bălăşineşti	1953-2017	0.59	2.27	71.44	18.65
Draghiste	Trinca	1957-2017	0.45	1.99	62.85	14.14
Ciuhur	Bârlădeni	1974-2017	0.28	2.48	62.04	8.93
Căldăruşa	Cajba	1951-2014	0.14	1.76	55.40	4.40

Source: SHS. Hydrological Yearbooks [35]

Based on the analysis of multiannual flows hydrographs of the Dniester River for the period 1968-2020, it can be seen that the general trend of flows is decreasing. Periods with maximum values followed by periods with minimum flow values are also recorded. Thus, the highest runoff was monitored for: 1968-1982 and 1997-2010, the duration being 15 years. The average flow values for the first period are 354 m^3/s, and for the second - 342 m^3/s. Lower runoff were recorded for: 1983-1996 and 2011-2020, the duration of the first period being 13 years, and the flows being 250 m^3/s. (Figure 1). The maximum annual flows and volumes recorded are 550 m^3/s, 17.3 km^3 (1980), 459 m^3/s, 14.5 km^3 (1998), and the minimum - 174 m^3/s, 5.47 km^3 (1987) and 183 m^3/s and 5.78 km^3 (1990).

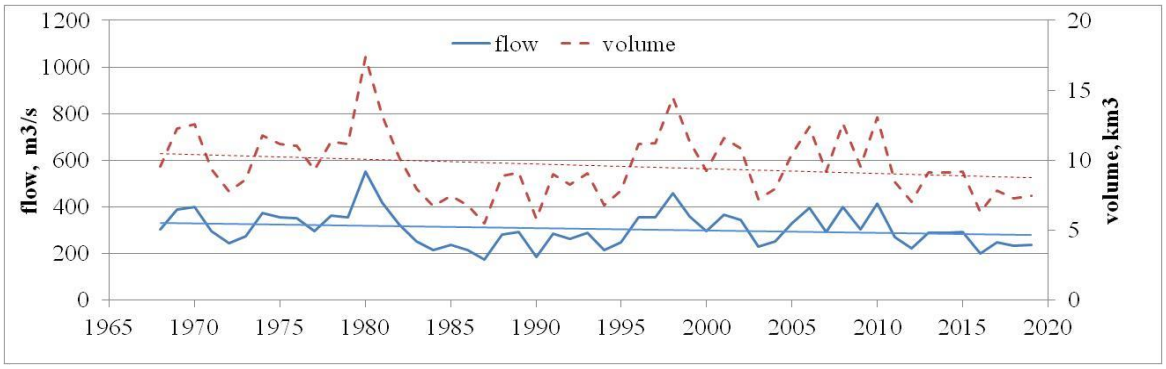

Figure 1. Multiannual flows hydrographs of the Dniester River, Grushka station.
Source: calculated by the author based on [35-36]

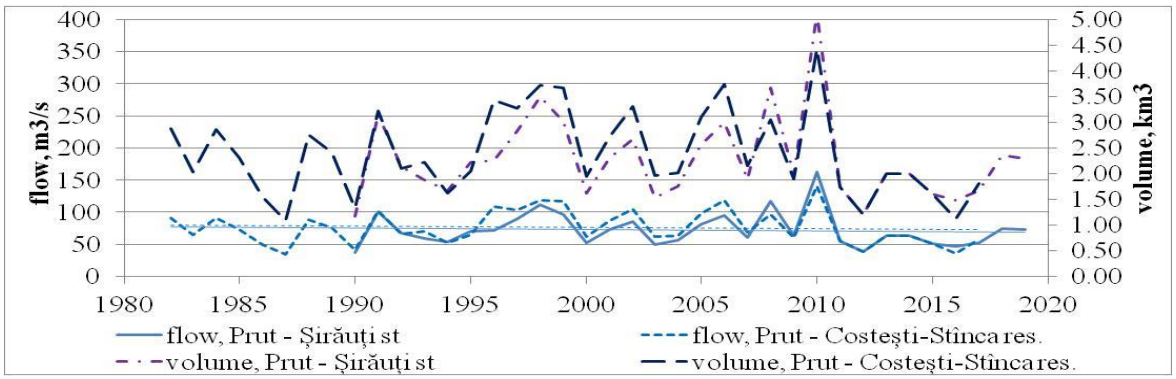

Figure 2. Multiannual flows hydrographs of the Prut River, Costeşti-Stânca reservoir station.
Source: calculated by the author based on [35-36]

The Prut River is an important water resource for the population and economic activities, it flows in the western part of the region. The flow of the Prut River is regulated by the Costeşti-Stânca reservoir, located in the middle course of the river [24]. Within the limits of North DR, the flow of the Prut river is monitored at the hydrological stations from Sirauti (Briceni district) and Costeşti, discharge from Costeşti-Stânca reservoir (Râşcani district), and the water level – at the stations from Lipcani, Dumeni and Braniştе. At the hydrological station from Sirauti, flow is, on average, 72 m^3/s, layer – 247 mm, and volume – 2.3 km^3. At the Costeşti, flow is, on average, 76 m^3/s, layer – 203 mm, and volume - 2.4 km^3.

Analysing the evolution of the Prut river flow values, trends similar to those for the Dniester river can be observed. Thus, the period with lower flows lasts until 1996. During the years 1997-2010 there are high flow values, and during the years 2011-2020 – low water volumes (Figures 1 and 2). The highest annual flows and volumes were 141 m^3/s, 4.4 km^3 – in 2010, and 119 m^3/s, 3.74 km^3 – in 2006, and the lowest – 34.4 m^3/s, 1.09 km^3 in 1987, and, 35.6 m^3/s, 1.12 km^3 in 2016.

Water resources distribution during the year is non-uniform, being directly influenced by precipitation regime. As can be seen from the figures below, the most important water resources are generated in spring and summer, when maximum amounts of precipitation are recorded. During these seasons, about 60% of the total water volume of the Dniester River is formed. The month with the highest flows is April, during which 480 m^3/s are observed, followed by May-July, with flows of 370-400 m^3/s. The smallest volumes of water are specific for the autumn and winter seasons. About 20% of the water volumes are formed during mentioned season each, and at monthly level, the water flows are almost identical, varying in the limits of 214-260 m^3/s (Figures 3 and 4).

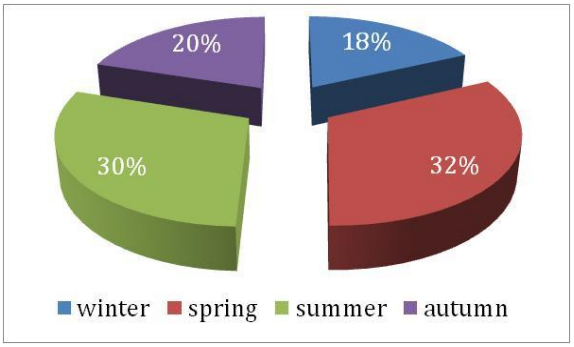

Figure 3. Seasonal distribution of the Dniester river flow, Grushka station [calculated based on 35-36].

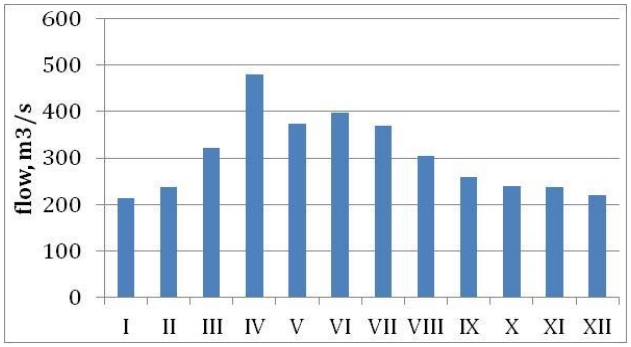

Figure 4. Monthly flows of the Dniester river, Grushka station [calculated based on 35-36].

The highest values of the Prut River flow are also formed in the spring and summer seasons, their share rising up to 70% (35% for each season). Flows during April-July reach values of over 100 m^3/s, and in the other months these gradually decrease up to ≈40 m^3/s in autumn and winter months (Figures 5 and 6).

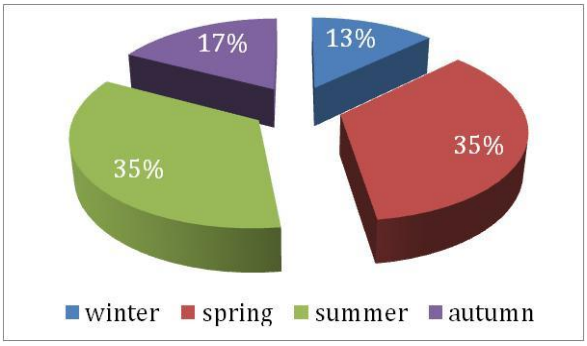

Figure 5. Seasonal distribution of the Prut river flow, Sirăuţi station [calculated based on 35-36].

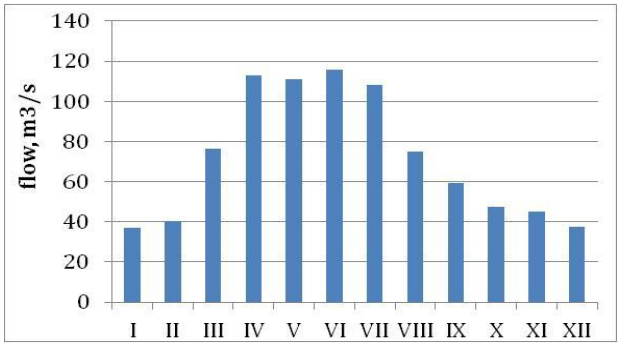

Figure 6. Monthly flows of the Prut river, Sirăuţi station [calculated based on 35-36].

Small and medium-sized rivers

Small and medium-sized rivers represent important water resources at local level, which are formed largely within the boundaries of the North DR. The main small and medium-sized rivers are located in the Dniester river basin: Răut, Cubolta, Căinari, Ciulucul Mic, and in the Prut river basin: Camenca, Ciuhur, Racovăţ, Vilia, Draghişte, Şovăţ, etc. The highest flows are also specific to the rivers in the Dniester river basin (Table 1). The rivers Cubolta, Răuţ and Căinari are characterized by flows equal to 1.3-1.5 m^3/s, layer – of 43-60 mm, and volume 41-52 mil.m^3. Flow dynamics show declining trends of Cubolta and Răut rivers flows.

The river flows from the Prut basin are lower, being about 0.14-0.60 m^3/s, and the volumes: of 4.4-19 mil. m^3, the layer being higher: 55-71 mm. Vilia and Draghişte have average flows of 0.59 and 0.45 m^3/s, and Ciuhur and Căldăruşa – of 0.28 and 0.14 m^3/s, the specific flow is within the limits of 1.8-2.5 $l/s\ km^2$. The layer is 71 mm for Vilia, about 62 mm for Draghişte and Ciuhur and 55 mm for Căldăruşa. The volumes are about 4,000,000 m^3 – for the Căldăruşa river, 9,000,000 m^3 – for the Ciuhur river and 14,000,000-18,000,000 m^3 – for the Draghişte and Vilia rivers. The trends of rivers flow from the Prut river basin, in the case of the Vilia river are slightly increasing, and of the Draghişte, Ciuhur and Căldăruşa rivers are decreasing.

Analysis of monthly flow of small and medium rivers shows that the most important water resources are also formed in the spring period followed by the summer. The smallest resources are formed in autumn and winter. Climate change in recent decades has led to a reduction in water resources, highlighting the months of March-July [22-23].

5.1.2. Groundwater resources

Most aquifers are composed of limestone and sandstone in the north, and more sand in the south. Direction of groundwater flow is in accordance with the geological structure. The oldest groundwater is found in the western and southwestern part of the country where the groundwater of the lower aquifers is captive, anaerobic and with a progressive salinity. Older aquifers are located in the eastern part of the study region [8, pp. 18-19].

Groundwater distribution of the *Vendian-Ripheric aquifer complex (V-R)* is in the eastern extremity of the region, in the Dniester river valley. The supply of this complex is made from the Podolia Plateau. The waters of this horizon are located at great depths, being difficult to access.

Groundwater within the *Cretaceous-Silurian aquifer complex (K2-S)* is spread over the entire territory of the North DR, except Sângerei district. The depth of groundwater varies between 104-3 m. The flow values are within the limits of 1.4-2.7 l/ sec, less often, of 0.1-0.3 l/sec. Mineralization ranges from 0.5 g/l to 1.0 g/l. According to the fluoride content, the groundwater of this complex does not comply with the quality standards and is not recommended for consumption by the population [20], but there are cases of their abstraction from wells and even from artesian wells.

Groundwater within the *Badenian-Sarmatian aquifer complex (N1b-S1)* is also spread over the entire North DR territory. The flow of the wells differs from one area to another, being in the limits of 0.1-2.2 l/sec (Dondușeni, Ocnița district) and 0.1-0.3 l/sec (Glodeni and Fălești districts). Groundwater mineralization varies from 0.5-1.0 g/l. The waters of the Badenian-Sarmatian aquifer complex largely comply with water quality standards and are widely used by public systems for the centralized supply of population with drinking water.

The *Alluvial-Deluvial aquifer horizon (aA3)* is specific to river floodplain. The waters of this horizon are extracted by population located in these areas from wells and springs. The thickness of the aquifers varies from 1 m to 30 m. The flow rates of the springs are from 0.01 l/sec to 1-2 l/sec. Mineralization varies from about 1 g/l to 10 g/l. Groundwater is fresh to slightly saline

5.2. Status and use of water abstracted systems

According to National Bureau of Statistics (NBS) [38], in the analysed period (2010-2020), the total volume of abstracted water for public water supply systems in the North DR was, on average, 18,800,000 m^3, including 16,200,000 m^3 or 87% in urban areas and 2,700,000 m^3 or 13% in rural areas (Figure 7).

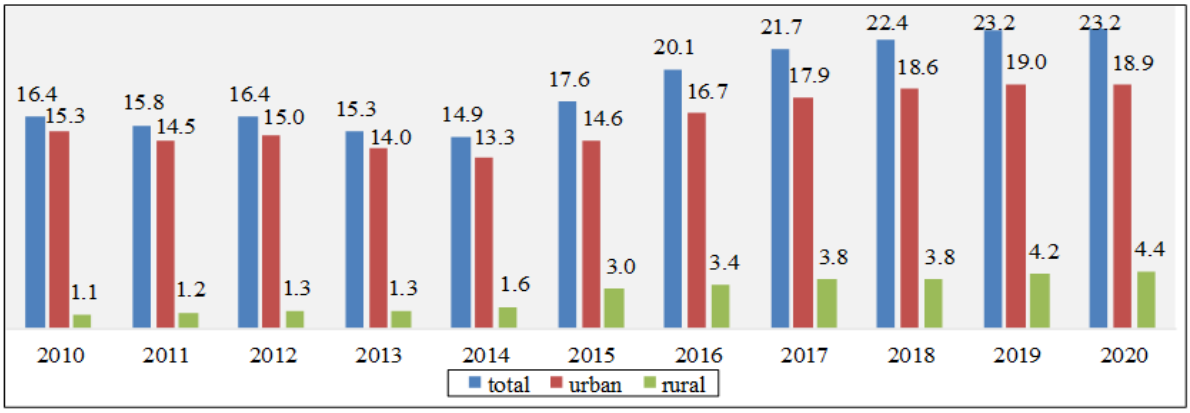

Figure 7. Dynamics of the total volume of abstracted water in the North RD, in mil. m^3.
Source: National Bureau of Statistics [38]

The maximum volume of abstracted water is registered in the districts of Soroca (11,300,000 m³) and Edinet (1,700,000 m³), where are located the main water pumping stations in the Dniester and Prut rivers, as well as in the districts of Drochia (937,000 m³), Florești (948,000 m³) and Sângerei (≈800,000 m³), with an average level of urbanization and with more extensive functional aqueducts in urban and rural areas. The minimum volume of captured water is registered in the districts of Ocnița (227,000 m³) and Briceni (538,000 m³), with smaller dimensions and urban centers and with less access to rural public aqueducts. The urban space predominates absolutely not only in Bălți municipality, but also in Edineț (88%), Drochia (75%) and Fălești (74%) districts, with urban centers of average sizes and a higher level of industrialization, as well as in the districts of Ocnița (100%) and Soroca (100%), with a very low level of access of the rural population to public aqueducts [7, p. 57].

In the urban area, the total volume of captured water increased by 3,500,000 m³ (from 15,300,000 m³ to 18,900,000 m³) or by 23% (Figure 7). This dynamic is predominantly conditioned by the similar evolution of the volume of abstracted water by SE Acva Nord from Soroca, which contributes about 60% of the delivered water to public aqueducts in the North DR and with 70% to urban public aqueducts in this region. At the same time, the abstracted water by SE Acva Nord is delivered, almost exclusively, in the municipalities of Bălți and Soroca, and the water distribution capacities are insufficiently exploited.

The total volume of abstracted water from surface sources were, on average, 13,100,000 m³ or about 70% of the total volume of water captured in the North RD, which is due, almost exclusively, to the pumping stations of the water supply companies SE Acva Nord from Soroca (11,300,000 m³) and from the Edineț city (1,500,000 m³). In the rest districts, the absolute majority of waters, especially in rural areas, are captured from underground sources.

During the analyzed period, the total volume of water captured from surface sources in the North DR increased by ≈1/4 or by about 4,000,000 m³ (from 12,100,00 m³ in 2010 to 16,200,000 m³ in 2019) (Figure 8). The respective dynamics is predominantly conditioned by the similar evolution of the respective indicator at SE Acva Nord Soroca, which registers an increase of 1.5 times or by 4,500,000 m³.

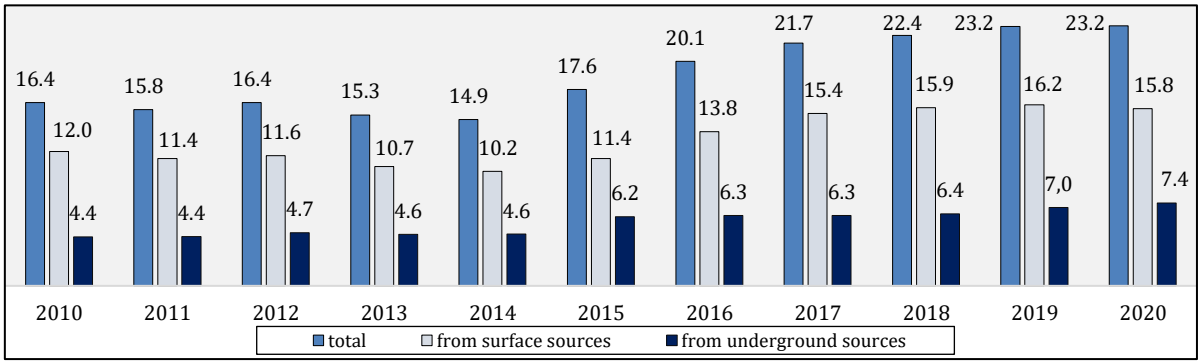

Figure 8. Dynamics of the abstracted water volume in the North RD by sources of origin, in mil. m³.
Source: National Bureau of Statistics [38]

Also, the insignificant increase of the volume of water captured from surface sources is registered in Fălești, Florești and Sângerei districts, as a result of the connection of some rural localities to the main aqueducts Prut-Fălești and Soroca-Bălți-Sângerei. At the same time, there is a significant reduction in the volume of captured water from surface sources in the Glodeni town (by 3.0 times), due to the bankruptcy of the sugar factory and in the Edinet town, due to the reduction of domestic and industrial consumption.

The total volume of water captured from underground sources in the North DR increased by ≈1.7 times or with about 3,000,000 m³ (Figure 8). The positive dynamics is entirely due to the multiple increases (by 4.0 times or with 3.1 million m³) of the volume of captured water from underground sources in rural areas. In the urban space there is an oscillating evolution against the background of a general trend of weak reduction. The maximum increase is found in the districts of Edineț (2.2 times) and Soroca, where previously the public aqueducts were supplied, almost exclusively, from surface sources.

In the North RD, water is supplied by about 350 pumping stations, of which about 230 stations are located in rural areas [38]. The pumping stations, which distribute the water for domestic use captured from the banks of the Dniester and Prut rivers, serve the main aqueducts Soroca-Bălți-Sângerei, Prut-Edineț, Prut-Glodeni and Prut-Fălești, with their branches. At the same time, are used only about ¼ of the design capacities of the existing stations, which is explained by their advanced degree of wear.

According to data from the Inspectorate for Environmental Protection (IEP), in the region there are 1382 artesian wells, of which only 38% are exploited. The high share of unexploited artesian wells is caused by advanced wear, by the insufficient financial capacity of LPAs for this purpose, but also by their

incorrect location. Despite the mentioned technical deficiencies, the production capacity of the existing catchment facilities is sufficient to cover the current water need of 22,000 m³/day [31, p. 17].

The water treatment plants operate at the main mentioned aqueducts for the distribution of water captured from the Dniester and Prut rivers. At the same time, in the absolute majority of rural localities, which capture water from underground sources, water is not treated according to the regulations in force, and chlorination is insufficient and random. Therefore, water delivered to rural consumers often does not comply with sanitary regulations, especially the hardness and fluoride content [31, p. 22]. Water quality monitoring systems exist only in the urban areas, and episodic tests are performed by the laboratories of the Center for Public Health and the Center of Ecological Research from Bălți city.

5.3. Public water supply systems

In the 2010-2020 years, the number of public water supply systems in the North DR increased by 2.3 times or from 127 units to 299 units (Figure 9), of which 267 systems (91%) are operational. The positive dynamics is registered in all districts of the region, including Fălești (from 3 to 30 units), Soroca (by 5.5 times), Râșcani (by 4.9 times) and Edineț (by 4.8 times), Dondușeni districts (by 3.7 times).

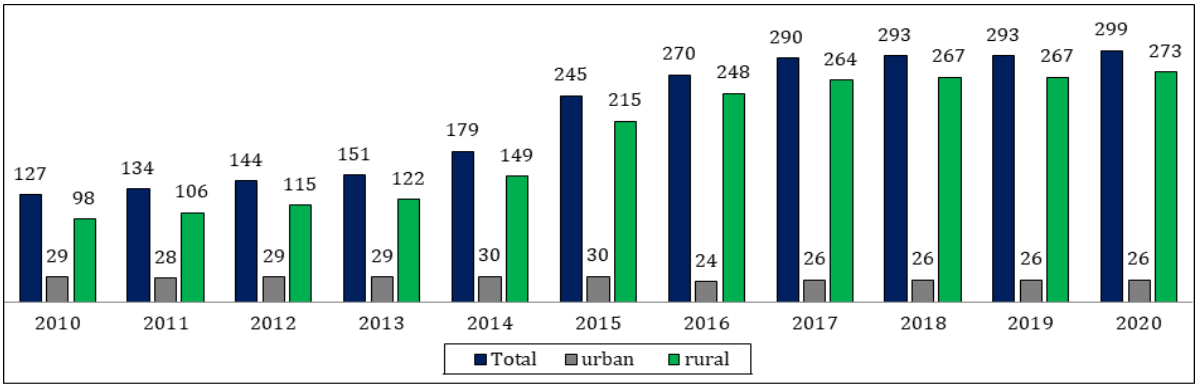

Figure 9. Dynamics of the number of public water supply systems, units.
Source: National Bureau of Statistics [38]

In the 2020 year, in the North DR were registered 299 public water supply systems, including 273 systems (88%) in rural areas and 26 systems (12%) in urban areas. The maximum number of public water supply systems is attested in the districts of Sângerei (49), Florești (48) and Râșcani (44), which are also characterized by a maximum access of the population to public aqueducts, especially in rural areas (Table 2). The highest growth rates are in the 2013-2016 years, due to the allocation of planned financial support from the National Ecological Fund [41] in order to achieve the objectives of the Water Supply and Sanitation Strategy [29], the National Program for the implementation of the Protocol on Water and Health (2016-2025) [30], the Regional Sectorial Program for water supply and sanitation [31]. Overall, the number of rural public aqueducts increased 2.7 times (from 98 to 267 units). At the same time, in urban areas, the number of public water supply systems decreased by 3 units (10%).

Table 2. Status and access of public water supply systems in the districts of North RD (year 2020).

	Districts	**Number of systems**			**Length of public aqueducts**, in km			**Number of connected population**, in thousand			**Access of the population to public aqueducts**, in %		
		total	urban	rural	total	urban	rural	total	urban	rural	total	urban	rural
1	Briceni	25	4	21	214	77.7	136	17.8	9.2	8.6	24	70	14
2	Ocnița	3	3	0	63.7	63.7	0	8.1	8.1	0	16	45	0
3	Edineț	24	3	21	244	121	122	28.6	17.1	11.5	37	67	22
4	Dondușeni	11	2	9	107	43.0	63,8	11.1	4.7	6.4	27	52	20
5	Soroca	17	2	15	398	175	211	42.9	31,8	11,2	46	91	19
6	Drochia	21	1	20	389	70,5	318	32.5	14,2	18,3	40	83	29
7	Florești	48	3	45	536	125	412	40,7	16,1	24,6	50	96	38
8	Sângerei	49	3	46	452	67.7	384	46.8	14.5	32.3	56	91	48
9	Râșcani	44	2	42	461	60.6	400	44.9	13.6	31.3	72	*97*	63
10	Glodeni	25	1	24	276	58.6	217	23.9	8.5	15.4	44	87	34
11	Fălești	30	1	29	378	47.2	331	37.8	15.7	22.1	45	*99*	32
12	Bălți	2	1	1	258	244	14.3	105	104	1.0	82	85	20
	North DR	**299**	**26**	**273**	**3,776**	**1,154**	**2,622**	**440**	**257**	**183**	**48**	**83**	**31**

Source: National Bureau of Statistics [38]

The total length of public aqueducts is ≈3,800 km, including 2,600 km (69%) in the rural areas and 1,200 km (31%) – in the urban areas (Table 2). During the 2010-2020 years this indicator increased by 2.1 times or with ≈2.0 ths km, including in rural areas – by 4.0 times (figure 10). In the urban space, there is an oscillating evolution, against the background of a negative dynamic in recent years, including Bălți municipality, Glodeni and Florești districts, being caused by the disconnection of industrial enterprises from the public water supply system.

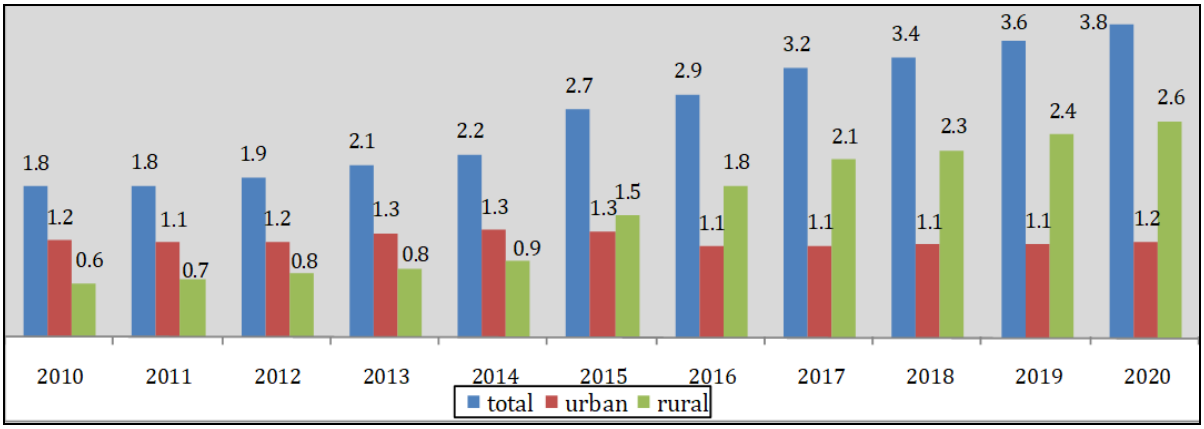

Figure 10. Dynamics of the length of public water supply systems in the North DR, in thousands km.
Source: National Bureau of Statistics [38]

The most extensive aqueducts are in the districts of Florești (536 km), Râșcani (461 km), Sângerei (452 km), Soroca (398 km) and Fălești (378 km), with a larger number of localities connected to public aqueducts (Figure 11). The minimum length of the aqueducts is also found in the districts of Ocnița (63.7 km) and Dondușeni (107 km) with smaller dimensions and a small number of localities connected to public aqueducts. The most extensive urban public aqueducts are in the municipalities of Bălți (258 km), Soroca (149 km) and Edineț (85.2 km), as well as in the Florești (93.6 km) and Drochia towns (70.5 km).

In the rural areas, water distributed by public water supply systems is used also for irrigation or frequent washing of transport units, which poses increased risks in the operation of those systems, especially water shortages in the droughts periods, insufficient of pressure, increasing of unauthorized use of water from the system etc [24,33].

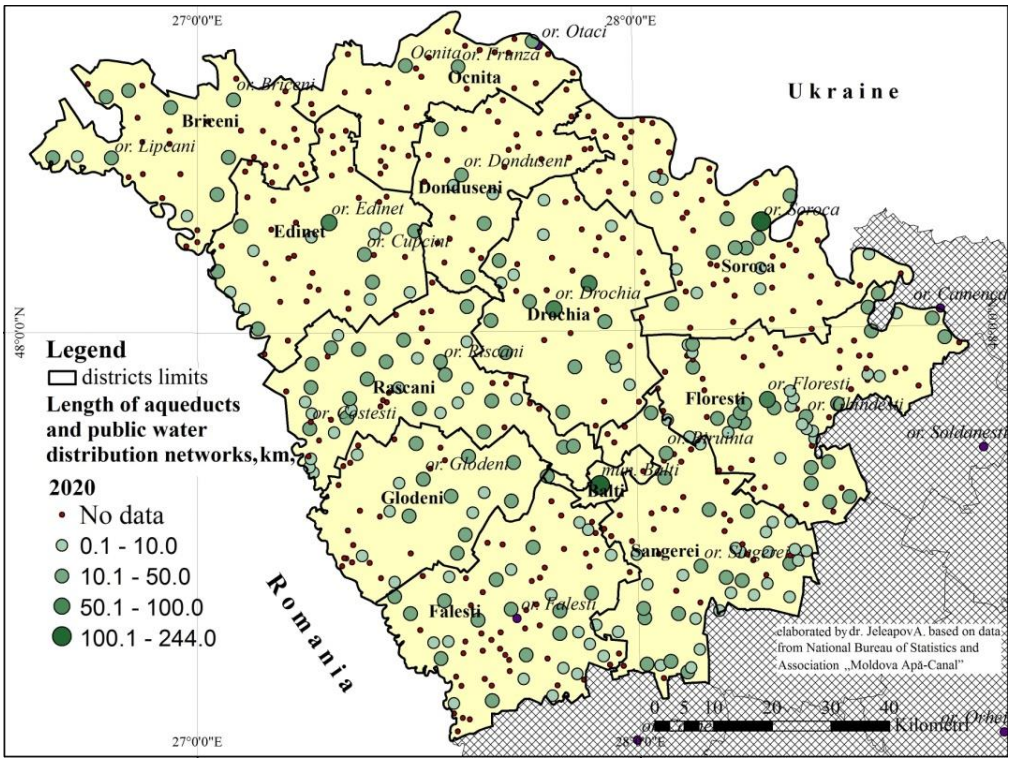

Figure 11. Length of public aqueducts in the localities of the North DR, in km, year 2020.
Source: National Bureau of Statistics [38]

As a result of the expansion of the aqueduct network, ≈½ (48%) of the population of the North DR has access to public water supply systems, including 83% in urban areas and only 31% in rural areas (Table 2). The maximum access of the population to public aqueducts is attested in Bălți municipality (82%), in Râșcani districts (72%), Sângerei (56%) and Florești (50%), and the minimum access in Ocnița districts (16%), Briceni (24%) and Dondușeni (27%).

5.4. The volume of used water delivered by public water supply systems

In the analyzed period (2010-2020), the total volume of water supplied by the public water supply systems registers an ascending dynamic, both in the rural and in the urban areas. Overall, the volume of used water increased 1.5 times, including in the urban areas, by 34% (from 15,100,000 m³ to 20,200,000 m³), and in the rural areas – by 3.6 times (from 983,000 m³ to 3,500,000 m³) (Figure 12).

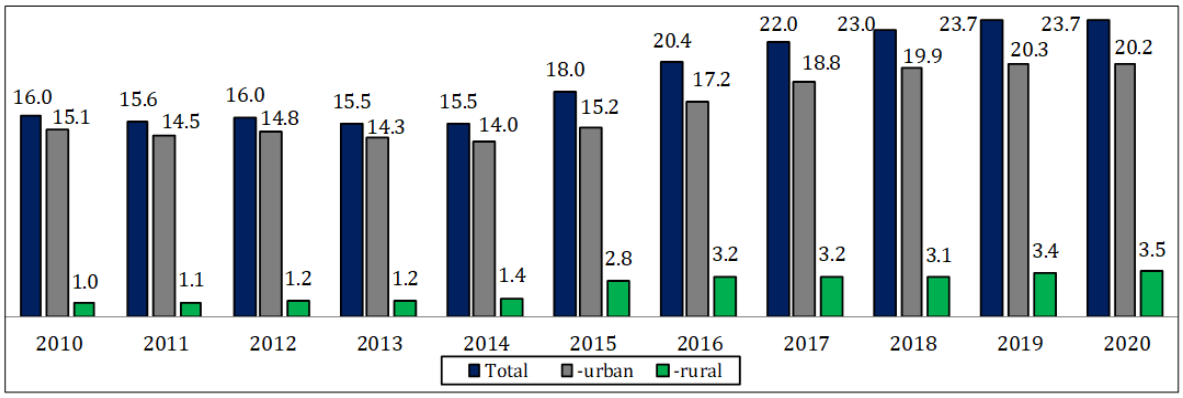

Figure 12. Dynamics of the total volume of water delivered by public water supply systems (mil. m3).
Source: National Bureau of Statistics [38].

The multiple increases in the volume of water delivered by public aqueducts are attested in the districts of Dondușeni (by 5.2 times until 2019), Drochia (by 3.3 times), Râșcani (by 3.2 times), Fălești (by 2.4 times) and Sângerei (by 2.1 times). The reduction (by ≈2 times) of the volume of water delivered is registered only in the Glodeni district, which is due to the cessation of the activity of the sugar factory from Glodeni town, which supplied water to this city. Given the declining of population, with the exception of attractive suburban areas, water consumption will be reduced and some of the newly built aqueducts will become dysfunctional. At the same time, the multiple conveniences of centralized water supply, especially in suburban communes with various economic opportunities, will increase water consumption. The volume of supplied water varies depending on the size of the districts and their urban centers, by the number and size of public aqueducts, by the number of connected people, by the number and consumption of water of enterprises and organizations connected to public aqueducts, by water reserves [4-5] and their technical and financial capacity to operate. Due to high water losses, only ½ of the abstracted water is delivered to consumers [31, p.20].

Table 3. Volume of delivered water by public aqueducts in the districts and cities of the North DR, in thousand m³ (2020 year).

	Districts	**Categories of water users**												**Water consumption per capita**, litres/day		
		Total			Households			Budget organization			Other categories					
		total	urban	rural	total	urban	rural	total	urban	rural	total	urban	rural	total	urban	rural
1	Briceni	357	195	163	320	175	145	25.9	11.3	14.6	11.6	8.4	3.2	55	58	52
2	Ocnița	168	168	0	144	144	0	18.5	18.5	0	4.7	4.7	0	57	57	...
3	Edineț	605	314	291	545	264	281	24.1	14.5	9.7	35.8	35.8	0	58	50	69
4	Dondușeni	213	105	108	186	94	92	17.9	5.2	12.7	8.5	5.7	2.8	52	61	46
5	Soroca	13,335	13,144	191	846	662	184	92.5	86.4	6.2	12,397	12,395	1.2	66	73	47
6	Drochia	988	395	593	920	360	560	38.2	17.3	20.9	25.3	18.0	7.3	83	76	89
7	Florești	873	396	477	768	346	422	37.7	25.2	12.4	67.7	25.6	42.1	59	68	53
8	Sângerei	808	308	500	743	276	467	45.3	19.4	25.9	19.1	12	7.1	47	58	42
9	Râșcani	852	274	578	785	249	535	40.5	13.4	27.1	27.2	11.6	15.6	52	55	51
10	Glodeni	438	159	280	404	140	263	25.6	15.1	10.5	9.4	3.1	6.3	50	51	50
11	Fălești	650	315	335	600	284	316	19.8	9.3	10.5	30.4	21.7	8.7	47	55	41
12	Bălți	4451	4427	24	3260	3238	21,8	230	229	0.2	961	959	2.4	116	117	69
North DR		**23,738**	**20,199**	**3,539**	**9,520**	**6,233**	**3,287**	**616**	**465**	**151**	**13,598**	**13,501**	**96.7**	**71**	**84**	**53**

Source: National Bureau of Statistics [38]

In 2020 year, the total volume of water supplied by public aqueducts in the North DR was 23.7 million m³, including 12,700,000 m³ of water delivered by the company Acva Nord Soroca and 10,800,000 m³ delivered by the operators of the public water supply services from the districts of the region and from the municipality of Bălți (Table 3). Large volumes of water are delivered in the municipality of Bălți (4,500,000 m³), as well as in the districts of Soroca and Drochia (1,000,000 m³ each), Florești (873,000 m³), Râșcani (852,000 m³) and Sângerei (808,000 m³). The minimum volume of water was delivered in the smaller districts and with a low level of access to public aqueducts – Ocnița (168,000 m³), Dondușeni (213,000 m³), Briceni (357,000 m³) and Glodeni (438,000 m³).

Despite much faster extension of the rural aqueducts, ≈90% of the total volume of water supplied is delivered by urban municipal enterprises. In the urban area, the maximum volume of water is also delivered in the cities of Soroca (850,000 m³), Drochia (395,000 m³) and Florești (330,000 m³), and the minimum volume − in the small towns such as Lipcani (33,900 m³), Mărculești (25,000 m³) and Ghindești (40,900 m³) from Florești district, Costești from Râșcani district (43,400 m³), Biruința from Sângerei district (47,000 m³) and Otaci from Ocnița district (71,000 m³). The urban space predominates in Bălți municipality (≈100%), as well as in Ocnița (100%), Soroca (≈100%), Briceni (54%) and Edineț (52%) districts (Figure 13). In the rest districts, the rural area predominates, including in the districts of Râșcani (68%), Glodeni (64%), Sângerei (62%), Drochia (60%), Florești (55%) and Fălești (52%).

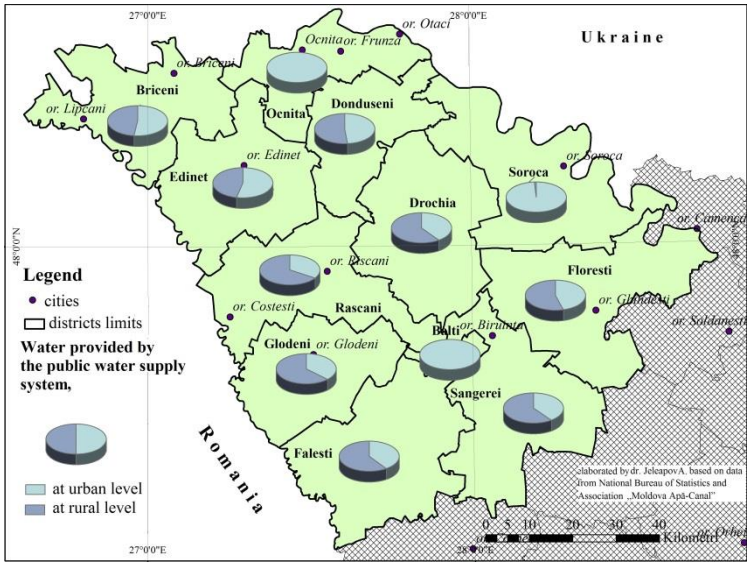

Figure 13. The share of urban and rural areas in the total volume of water provided by public water supply systems in the districts of RD Nord and Bălți municipality (year 2020).
Source: National Bureau of Statistics [38]

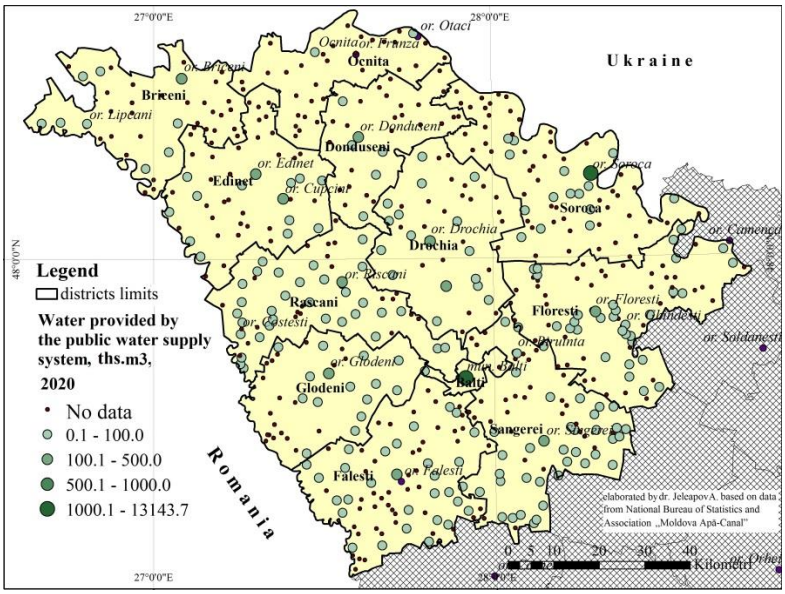

Figure 14. Total volume of water delivered by water supply systems in the localities from the North DR, in ths m³.
Source: National Bureau of Statistics [38]

In the rural areas, the maximum volume of water are provided in the villages with larger aqueducts (Figure 14), including: Larga (53,000 m³) from Briceni district; Bădragii Vechi (80,200 m³) and Brătuşeni (63,300 m³) from Edineţ district; Sofia (182,000 m³), Nicoreni (77,000 m³), Ţarigrad (72,200 m³), Pelinia (55,000 m³) and Chetrosu (52,000 m³) from Drochia district; Prodăneşti (70,000 m³), Gura Camencii (46,000 m³) and Vărvăreuca (44,000 m³) from Floreşti district; Sărata Veche (39,000 m³) from Făleşti district; Iabloana (63,000 m³) from Glodeni district; Corlăteni (88,000 m³), Zăicani (65,000 m³), Nihoreni (52,000 m³) and Mihăileni (45,000 m³) from Râşcani district; Pepeni (73,000 m³), Chişcăreni (52,000 m³), Heciul Nou (41,000 m³) from Sângerei district; Rubleniţa (43,000 m³) from Soroca district (Figure 14).

In the urban space were delivered, on average, 5,300,000 m³ of water or ≈¾ of the total volume (Table 3). As a result of the concentration of industrial enterprises in cities, the share of the volume of water supplied to the population in rural areas is higher compared to urban areas and constitutes about 90% in the absolute majority of the districts of the study region.

Overall, the dynamics of the volume of water supplied to the households (populations) is similarly to that of the total volume of water delivered by public aqueducts, but the positive trend is more pronounced and is observed in all districts and Bălţi municipality. Thus, the total volume of water supplied to the population increased by 1.8 times or from 5,300,000 m³ in 2010 to 9,500,000 m³ in 2020. In rural areas, the volume of water supplied to the population increased by 4.5 times (from 727,000 m³ to 3,300,000 m³), and in urban areas, with only 35% (from 4,600,000 m³ to 6,200,000 m³). As a result, the share of the rural space in the total volume of water supplied to the households of the North DR increased by more than 20 percentage points (p.p.) or from 14% to 35%. The multiple increase of the volume of water delivered to the households is observed in the districts of Drochia (by 3.4 times), Răşcani (by 3.3 times), Făleşti (by 3.2 times), Sângerei (by 2.3 times), Floreşti (by 2.2 times) and Edineţ (by 2.0 times), which is due, almost exclusively, to the multiple increase of this indicator in the rural localities.

In 2020 year, to the households was delivered 9,500,000 m³ or about 80% of the total volume (without water delivered by SE Acva Nord). This proportion is similar in all districts and cities of the region, except Balti municipality, with a higher share of industrial and transport enterprises, and the volume of water delivered to the households determines the total volume [7, p. 68-69]. In the urban areas were delivered 6,200,000 m³ (65%) of water and 3,300,000 m³ (35%) in the rural areas. The maximum volume of water delivered to the householders (Table 3) is attested in Bălţi municipality – 3,200,000 m³ (40%), as well as in the districts of Drochia (920,000 m³), Soroca (846,000 m³), Râşcani (785,000 m³), Floreşti (768,000 m³) and Sângerei (743,000 m³), and the minimum volume − in the small districts with a low level of access to public aqueducts, including Ocniţa (144,000 m³) and Donduşeni (186,000 m³).

In the urban space, the maximum volume of water is also delivered in the Bălţi city (3,200,000 m³), as well as in the town of Soroca (662,000 m³), Drochia (320,000 m³), Floreşti and Făleşti (about 280,000 m³ each), and the minimum volume − in the smaller towns, such as Lipcani (29,900 m³), Mărculeşti (20,100 m³) and Ghindeşti (39,800 m³) in Floreşti district, Costeşti in Râşcani district (40,100 m³), Biruinţa from Sângerei district (41,400 m³), Cupcini (75,400 m³) from Edineţ district; Ocniţa and Otaci from Ocniţa district (69,000 m³). The maximum volume of water delivered to the rural population is attested in the districts of Drochia (560,000 m³), Râşcani (535,000 m³), Sângerei (467,000 m³) and Floreşti (422,000 m³), which have a higher level of access to available sources of water (Table 3). The minimum volume of water use is registered in the smaller districts and/or with less access to aqueducts, including the districts of Ocniţa (0 m³), Soroca (184,000 m³) and Briceni (145,000 m³).

The volume of water delivered to other categories of consumers was, on average, 11,000,000 m³ (58%), and in 2020 – 13,600,000 m³ (57%), of which 12,700,000 m³ (90%) delivered by SE Acva Nord Soroca to the operators and enterprises from Bălţi municipality and from the localities related to the Soroca-Bălţi main aqueduct, as well as its extensions to the cities of Sângerei and Râşcani.

For industrial and services enterprises connected to local public aqueducts were delivered ≈1,400,000 m³ (13%), of which over 90% (1,200,000 m³) – in the urban area, where are concentrated most of industrial and service enterprises. The volume of water delivered to these categories of water consumers is conditioned by the number and production capacity of enterprises, which do not have their own sources of water supply [7, p. 72]. Therefore, the maximum volume of water delivered to enterprises is observed in the cities of Bălţi (959,000 m³), Soroca (100,000 m³) and Edineţ (130,000 m³).

For budget organizations, was delivered, an average 733,000 m³ of water or ≈7% of the total volume, including 484,000 m³ (66%) in urban areas (Table 3). Unlike industrial enterprises, budget organizations, especially educational insurance and public administration, are widespread in rural areas. Among the budgetary organizations we mention the hospitals from Bălţi municipality and from the district centers, the educational and administrative centers, which are widespread as well in rural areas. The maximum volume of water delivered to budget organizations is recorded in larger cities, including Bălţi (254,000 m³), Soroca (86,400 m³), Floreşti (24,000 m³) and Edineţ (21,000 m³).

Despite the rapid expansion of water supply networks, water consumption per capita is low and is only 71 liters/day, including 84 liters/day in urban areas and 53 liters/day in rural areas (Table 3) or twice, less than the norm of water consumption for the population. Water consumption is directly conditioned by both the number of connected population and the amount of local water resources [33]. Thus, the maximum water consumption per capita is observed in Bălți municipality (116 l/day), as well as in the districts of Dondușeni (130 l/day in 2019) and Drochia (88 l/day), and the minimum consumption – <50 liters/day is attested in Fălești and Sângerei districts with limited groundwater reserves.

5.5. Public wastewater treatment and purification systems

There are only 52 public sewerage systems in the North RD or ≈6 times less than the public water supply systems (Tables 4). The number of sewerage systems in urban areas is identical to that in rural areas, but the capacity for receiving and treating wastewater is much higher. Also, in Glodeni and Florești districts, the large number of public sewerage systems is explained by the fact that small systems have been registered, which include several public institutions (kindergartens, schools) and households around them. Maximum number of public sewerages systems is registered in the districts of Florești (12), Râșcani (6), Edineț and Dondușeni (5 each).

Table 4. Status of public wastewater disposal and purification systems in the North DR (2020).

Districts	**Number of public sewerage systems**			**Length of sewerage network**, in km		**Access to the public sewerage systems**, in %			**Number of treatment plants**			**Capacity of treatment plants**, m^3/day	
	Total	urban	rural	Total	urban	Total	urban	Rural	Total	urban	rural	Total	urban
Briceni	3	3	0	31.4	31.4	6.8	37	0	1	1	0	1,200	1,200
Ocnița	4	4	0	18.2	18.2	9.3	27	0	3	3	0	217	217
Edineț	5	3	2	55.2	53.7	13	40	0	3	2	1	1,100	1,100
Dondușeni	5	2	3	27.0	15.8	14	52	3.5	3	1	2	1,500	..
Drochia	4	2	2	45.5	45.5	13	59	0	1	1	0	729	729
Soroca	1	1	0	54.8	54.8	21	56	0	1	1	0	0	0
Florești	12	3	9	49.6	40.9	12	58	0.3	6	2	4	720	600
Râșcani	6	2	4	49.1	38.7	8.9	43	0.2	4	2	2	1,126	926
Glodeni	4	1	3	18.2	18.2	11	62	0	7	1	6	0	..
Fălești	2	1	1	48	40	11	62	0	1	1	0	683	683
Bălți	2	1	1	156	152	63	65	9.8	2	1	1	2,450	2,450
Sângerei	4	3	1	37.6	34.1	8.8	46	0	1	1	0	350	350
Total	**52**	**26**	**26**	**591**	**544**	**19**	**55**	**0,3**	**34**	**18**	**16**	**10,075**	**8,255**

Sources: National Bureau of Statistics [38], Association „Moldova Apa-Canal" [40]

If the number of water supply systems registers a very fast increase, by about 2.3 times, then the number of centralized sewerage systems registers an oscillating evolution against the background of a general negative trend, and the negative dynamics is found in about ½ from the districts of the region. As a result, the coverage of water supply systems with sewerage systems decreased in the analyzed period from 45% to 18%. The lack of progress in expanding centralized sewerage systems is largely due to higher costs compared to water supply systems, and most of rural people and of local public authorities do not consider this a priority [9,10,31].

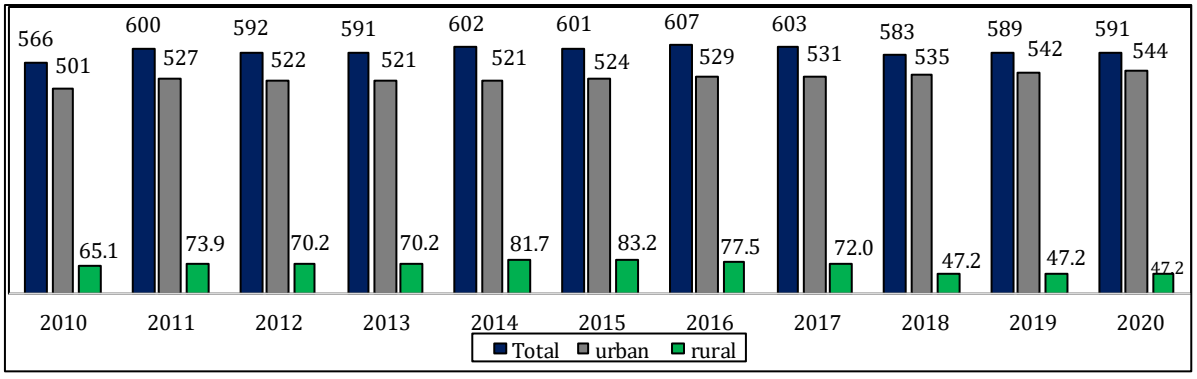

Figure 15. Dynamics of the length of public sewerage systems in North RD, km.
Sources: National Bureau of Statistics [38], Association „Moldova Apa-Canal" [40]

The length of the sewerage public systems in the North RD is about 591 km, including about 544 km (92%) in the urban areas and only 47.2 km – in the rural areas (Table 4). During the analyzed period, the length of the public sewerage systems of the study region oscillates around 600 km. In the urban area

there is a slight increase (+9%) or from 501 km in 2010 year to 544 km in 2020 year. At the same time, in the rural space there is a pronounced oscillating evolution, conditioned both by the real dynamics of this indicator and by the level of evidence of the statistical and ecological authorities in the territory. Thus, from 2010 to 2015, the number of public sewerage systems in rural areas increased by 18 km, after which it decreases to 47.2 km in 2018 (Figure 15).

In 2020 year, the most extensive urban sewerage networks operate in larger cities, including Bălți (152 km), Soroca (54.8 km), Drochia (45.5 km), Fălești (40.0 km). The minimum length is found in small towns (Figure 15.), including Lipcani (1.4 km) in the district of Briceni, Otaci (3.0 km), Ocnița (4.6 km) and Frunză (10.6 km) in the district of Ocnița, Ghindești (10.9 km) from Florești district, Dondușeni (15.8 km) and Costești from Râșcani district (17.6 km) and Biruința (17.7) from Sângerei district (Table 4).

In the rural area, the most extensive sewerage networks are in the districts of Dondușeni (11.2 km) and Râșcani (10.4 km), and in the districts of Ocnița, Briceni, Fălești, Drochia and Soroca they do not exist. The most extensive rural sewerage networks operate in the villages of Duruitoarea (9.2 km) from Râșcani district and in Țaul (8.0 km) from Dondușeni district.

Despite the ambitious launch of the Water Supply and Sanitation Strategy [29], only 19% of the population in the North DR have access to centralized sewage services, including 0.3% – in rural areas and 55% – in urban areas (Table 4). The maximum access is attested in Bălți municipality (63%), as well as in Soroca districts (21%), Dondușeni (14%), which have more extensive sewerage networks. In the urban area, the maximum access is also attested in the cities of Fălești (63%), Glodeni (62%), Drochia (59%), Florești (58%) and Soroca (56%). In the districts of Soroca, Ocnița, Fălești, Glodeni, Edineț and Sângerei, have been started projects for the regionalization of water supply and sanitation services [31, 41], which will significantly increase the profitability of the respective services.

5.5.1. Use of public sewerage systems

The total volume of wastewater discharged through public sewerage networks is about 10,500,000 m^3, of which over ¾ (8,200,000 m^3) come from Bălți municipality (Table 5). During the years 2010-2020 there is a slight increase (+ 9%) of the total volume of wastewater discharged through public sewerage networks (Figure 16).

The positive dynamics is attested in 9 of the 11 districts and in the Bălți municipality. The maximum increase is observed in the districts of Dondușeni (by 1.9 times) and Ocnița (by 1.8 times), Fălești (by 1.7 times), Drochia (by 1.6 times). In Glodeni district there is a multiple reduction (by ≈5 times) of the volume of wastewater discharged, the main cause being the cessation of the activity of the sugar factory, which was also the largest generator of wastewater [33]. An insignificant reduction (by 1.2 times) is registered in Edineț district. The maximum volume of wastewater discharged into the public sewerage networks is attested in Bălți municipality (8,200,000 m^3) and the districts of Soroca (488,000 m^3) and Edineț (391,000 m^3). An average quantity was discharged in the public sanitation networks from Florești districts (248,000 m^3), Drochia (235,000 m^3), Fălești (208,000 m^3), and a minimum volume – in the smaller districts of the region (Table 5), including in Dondușeni and Râșcani (124,000 m^3) and Ocnița (70,000 m^3).

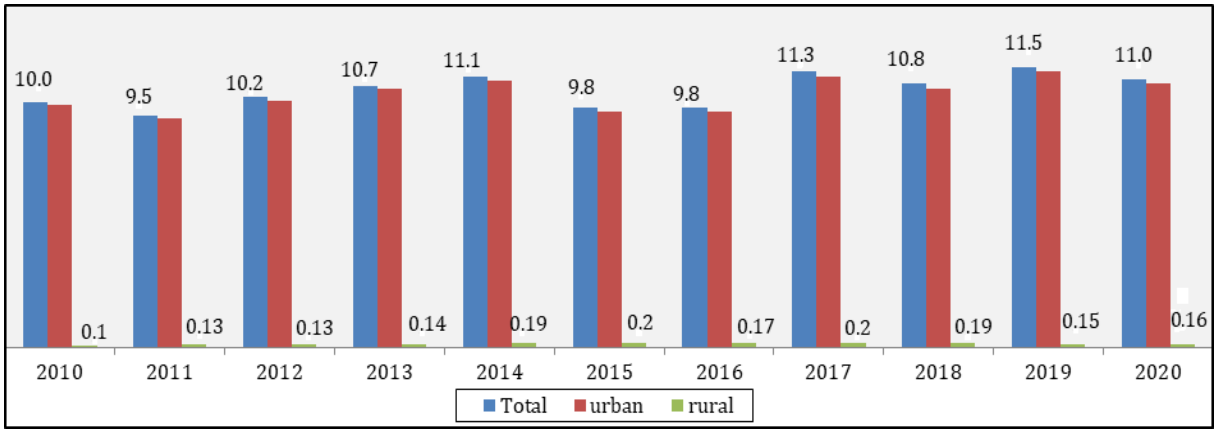

Figure 16. Dynamics of the total volume of wastewater discharged by public sewerage systems in the North RD.
Source: National Bureau of Statistics [38]

On average, 10,400,000 m^3 or 98% of the total volume of wastewater discharged into the public sewerage networks in the North RD come from urban areas, including ≈100% in the districts of Briceni, Ocnița, Drochia, Soroca, Sângerei and Bălți, and ≈90% in Edineț and Dondușeni districts (Table 5).

Wastewater discharged into public sewerage networks in rural areas are present in 6 districts, the largest share being in Edineţ (19%) and Dondușeni (23%) districts.

More than half (53%) of the total volume of water discharged into public sewerage systems is received from households, budget organizations and companies. In most districts of the region, the total volume of wastewater discharged and that received from subscribers is practically the same, except for Bălţi municipality and Glodeni and Fălești districts. In Bălţi, this difference is about 4.8 million m³ and includes rainwater discharged into the urban sewerage network [10].

Table 5. The volume of wastewater received by public sewerage systems in the districts of RD Nord, by categories of users and living space, average of 2011-2019, in thousands m³.

Districts	Total	Total				Households			Budget organization			Other categories		
		total	urban		rural	total		urban	total		urban	total		urban
		ths m³	ths m³	%	ths m³	ths m³	%	ths m³	ths m³	%	ths m³	ths m³	%	ths m³
Briceni	123	120	120	100	0	83	69	83.3	27.4	23	27.4	9.2	7.7	9.2
Ocniţa	71.6	62.7	62.7	100	0	54	86	53,8	6.1	10	6.1	2.8	4.5	2.8
Edineţ	391	380	313	82	67.3	139	37	138	95.7	25	29.3	146	38	146
Dondușeni	125	121	97	80	20.8	79	65	78.2	35.7	29	12.2	6.4	5.3	6.4
Drochia	237	232	232	100	0	181	78	181	14.4	6.2	14.4	36.7	16	36.7
Soroca	487	487	487	100	0	342	70	342	71.1	15	71.1	73.5	15	73.5
Floreşti	234	230	217	95	12.4	135	59	134	19.8	8.6	18.8	74.5	32	65.0
Râşcani	123	118	117	99	1.0	72	61	71.3	23.2	20	22.4	23.5	20	23.4
Glodeni	166	132	129	98	3.1	65	49	65.0	19.6	15	16.5	47.0	36	47.0
Fălești	206	179	164	92	14.7	139	78	125	9.2	5.1	8.5	31.1	17	30.3
Bălţi	8,221	3,429	3,429	42	8.1	2,280	66	2,273	327	9.5	326	822	24.0	821
Sângerei	146	135	146	108	0	95	70	94.9	27.7	20	27.7	12.7	9.4	12.7
RD Nord	**10,530**	**5,625**	**5,513**	**98**	**127**	**3,664**	**65**	**3,639**	**677**	**12**	**581**	**1,285**	**23**	**1,274**

Sources: National Bureau of Statistics [38], Association „Moldova Apa-Canal" [40]

Approximately 2/3 (3,700,000 m³) of the total volume of wastewater discharged is received from households. Also, about 2/3 of the total volume of wastewater received from the population comes from Bălţi. The maximum share (≥70%) of households is attested in Soroca, Drochia, Fălești, Ocnita districts (Table 5, Figure 17). In addition to Bălţi municipality (2,300,000 m³), the maximum volume of wastewater discharged by households is attested in the districts of Soroca (342,000 m³) and Drochia (181,000 m³), which have a larger population and it's a higher level of access to public sewerage networks [38]. An average amount was discharged into the public sanitation networks in the districts of Fălești, Edineţ (139,000 m³) and Floreşti (135,000 m³).

From the budget organizations were discharged 677,000 m³ (in 2019) or 12% of the total volume of wastewater discharged into the public sewerage systems in the North RD. The maximum volume of wastewater discharged by budget organizations is attested also in Bălţi (327,000 m³), as well as in the districts of Soroca (201,000 m³), Edineţ (96,000 m³), with larger urban centers and a larger number of budget organizations located in the mentioned regional and zonal centers. The maximum share of (30%) budgetary organizations is observed in Dondușeni district, where large social and medical institutions are located, connected to the rural public network.

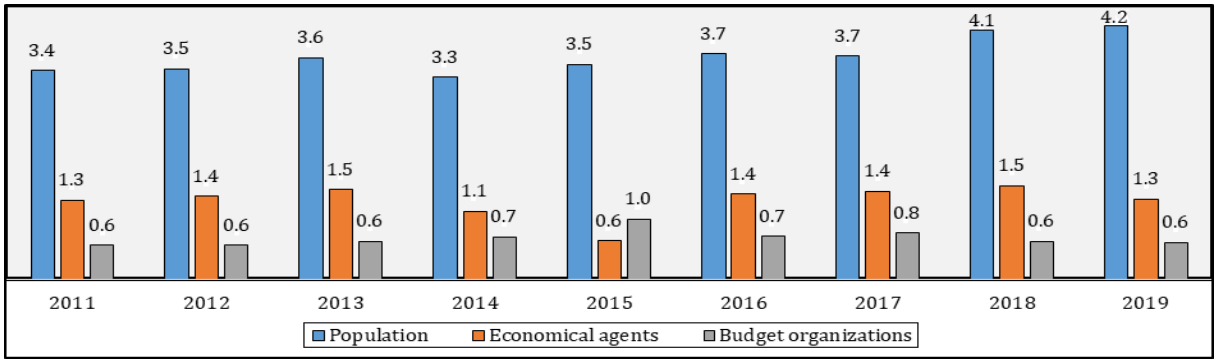

Figure 17. Dynamics of the volume of wastewater discharged in the public sewerage systems from RD Nord by categories of users, mil. m³.
Source: National Bureau of Statistics [38]

Approximately ¼ (1,300,000 m³) of discharged wastewater received from subscribers comes from other categories of consumers (industrial and service enterprises). In 2019, 822,000 m³ of wastewater or

≈2/3 (64%) of the total volume of wastewater received from subscribers in RD Nord were discharged from the enterprises in Bălți in the public sewerage networks, which is what due to the concentration on the territory of Bălți of the largest industrial enterprises from this region. Also, a large volume of wastewater was discharged by the enterprises from Edineț (146,000 m^3) and Florești (75,000 m^3) districts, with a higher level of industrialization. Almost all wastewater quantity is discharged by industrial enterprises from urban areas.

5.5.2. Wastewater treatment plants

The number of treatment plants decreased in the analyzed period from 42 to 34 units (Table 4), of which only 21 with functional treatment systems. In the rural areas, the number of treatment plants has decreased significantly from 23 units in 2010 to only 16 units in 2019 [38]. Similar to the number of sewerage systems, the maximum number of treatment plants in Florești (6) and Glodeni (7) districts is explained by the fact that small sewage treatment plants were registered, serving one or several public institutions (kindergartens, schools, town halls) [10].

Over 80% of the total volume of wastewaters received from public sewerage systems is passed through treatment plants and subjected to complex treatment, including 84% in urban areas and only ≈1/3 in rural areas. The complete purification of the wastewater discharged by the public sewerage systems takes place at the treatment plants from Bălți, Edineț (Cupcini), Drochia and Ocnița towns, where measures have been taken to modernize the technological processes and equipment. Also, the normative purification is performed at the recently built treatment plants from Lipcani and in the rural localities from Florești, Glodeni and Râșcani districts [31]. In addition, in recent years has increased the degree of wastewater purification at the biological treatment plants from Drochia, Sângerei and Râșcani towns.

In the years 2018-2020 only 6% (674,000 m^3) of the total volume of wastewater discharged by public sewerage systems in the North DR were insufficiently treated, including 6% (634,000 m^3) in urban areas and 26% (41,000 m^3) in rural areas. The wastewaters discharged by the municipal enterprises from the cities of Dondușeni, Sângerei, Fălești and Florești, as well as from the rural localities from Dondușeni district, which have treatment plants [40] are insufficiently treated. In addition, treatment plants do not operate in the Soroca, Briceni and Glodeni towns, as well as in the absolute majority of rural localities [10], which generates a significant harmful effect not only on aquatic ecosystems, water resources, but also on the health of the population in those areas.

6. CONCLUSIONS

Based on the hydrographic analysis of the water flows of the Dniester and Prut rivers, for the period 1968-2020, we can observe an oscillating evolution of their flows, against the background of a general downward trend, amplified by recent climate change and the operation of hydropower complexes.

It is absolutely necessary to declare the main aqueducts as national security objectives and to apply a rigorous control over their status and operation, at the same time as expanding the capacities for distributing and consuming of water captured from quality surface sources.

The length of public aqueducts has increased by 1.7 times, including in rural areas − by 3.7 times or by 1,800 km. As a result, ≈½ of population from the North RD has a lowest access to public aqueducts, including 83% in urban areas and only 31% − in rural areas. In Briceni, Ocnița, Dondușeni and Soroca districts, is attested the lowest level of access to public aqueducts from the country.

For the (households were delivered, on average, 7,300,000 m^3 or about 80% of the total volume (excluding water delivered by SE Acva Nord). This proportion is similar in all districts and cities of the region, except the municipality of Bălți, with a higher share of industrial and transport enterprises.

The total volume of water delivered to the population increased by 1.8 times (4,100,000 m^3), including in rural areas by 4.5 times (by 2,600,000 m^3), and in urban areas, by only 35 % (1,600,000 m^3). Despite the rapid expansion of public aqueducts, per capita water consumption is low and is only 71 liters/day, including 84 liters/day in urban areas and only 53 liters/day in rural areas.

In the study region, population access to the public sewerage systems is only 19%, including 55% in the urban areas and only 0.3% − in the rural areas. There are not public sewerage systems in the villages of Ocnița, Briceni, Fălești, Drochia and Soroca districts. Slow expansion of the public sewerage systems is caused by higher costs compared to water supply systems, and most local public authorities do not consider them as a priority.

For future research, we propose to analyze the water resources, as wel as status and use of public water supply and sewerage systems in other development region and on the hydrographical basins from Republic of Moldova.

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